



# **Armed Forces College of Medicine AFCM**



# **Histological structure of small intestine (I)**

**Dr. Nevine Bahaa**

**Prof. of Histology and cell biology**

## INTENDED LEARNING OBJECTIVES (ILO)



**By the end of this lecture the student will be able to:**

- Describe the histological structure of core of the small intestinal villi and their covering cells.
- Correlate the structure of the cells covering the small intestinal villi to their functions.
- Interpret the altered microscopic structure of the small intestine in different diseases.

## Key points of this lecture



1. Surface area of small intestine must be increased for absorption.
2. Structural modification of small intestinal mucosa.
3. Structure of enterocytes and goblet cells, enteroendocrine cells in relation to their functions.
4. Brush border structure, enzymes, function and disorders (lactose intolerance, Celiac disease).
5. Organelles involved in fat absorption: sER, Golgi and rER.

# General structure of small Intestine

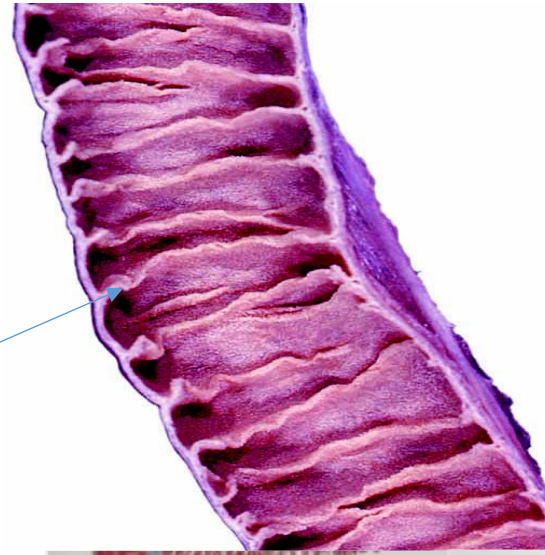


**The surface area of the lining of small intestine is increased by:**

**1- Plicae circulares:** (x3)  
= valves of Kerckring, seen by naked eye.  
- Permanent circular or semilunar folds consisting of mucosa and submucosa.

**2- Villi** (x10).

**3- Microvilli** (x20).



villi

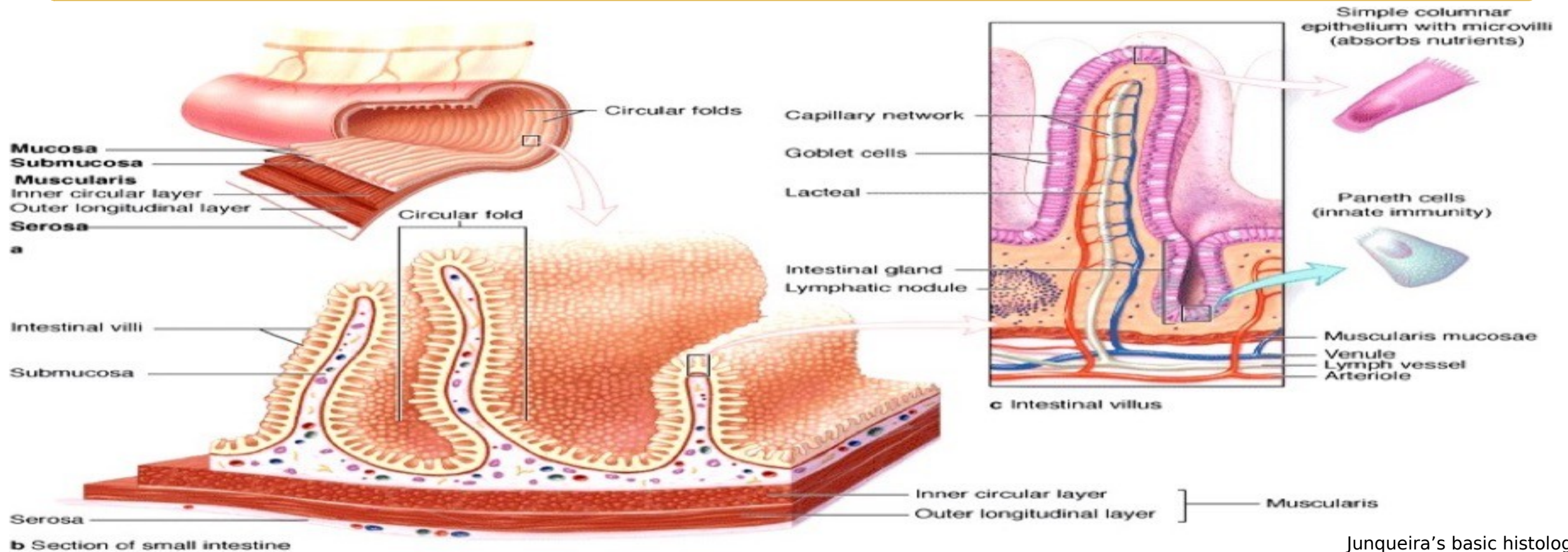


Junqueira's basic

Ross & Pawlina 7<sup>th</sup> ed



# General structure of small Intestine



Junqueira's basic histology

The small intestine consists of three parts: duodenum, jejunum and ileum. They share the general histological characteristics with few modifications.

## General structure of small intestine

### 1- Mucosa:

It is characterized by the appearance of:

- **Villi**: Finger like mucosal projections above the surface, covered by simple columnar epithelium.

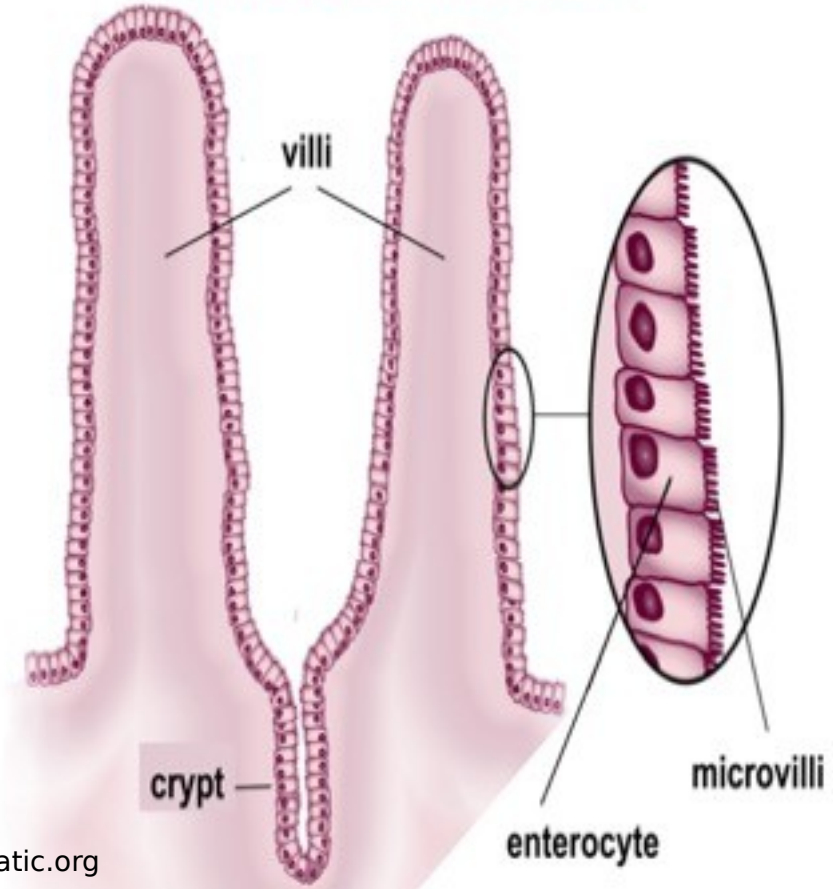
They give a velvet-like appearance by naked eye.

- **Simple tubular glands** (**Crypts of Lieberkühn**) that invaginate into the C.T. corium occupying its whole thickness.



Depositphotos.com

lumen of small intestine



## *General structure of small intestine*



### Mucosa consists of:

**a- Epithelial lining: simple columnar epith.**

**With goblet cells** cover the villi & line the crypts.

**b- Lamina propria:** Loose C.T., forming the cores of the villi and filling the spaces between the crypts. It is very rich in **blood capillaries, lymphocytes, Plasma cells & macrophages.**

**c- Muscularis mucosa:** smooth muscle : **(I.C, O.L).**





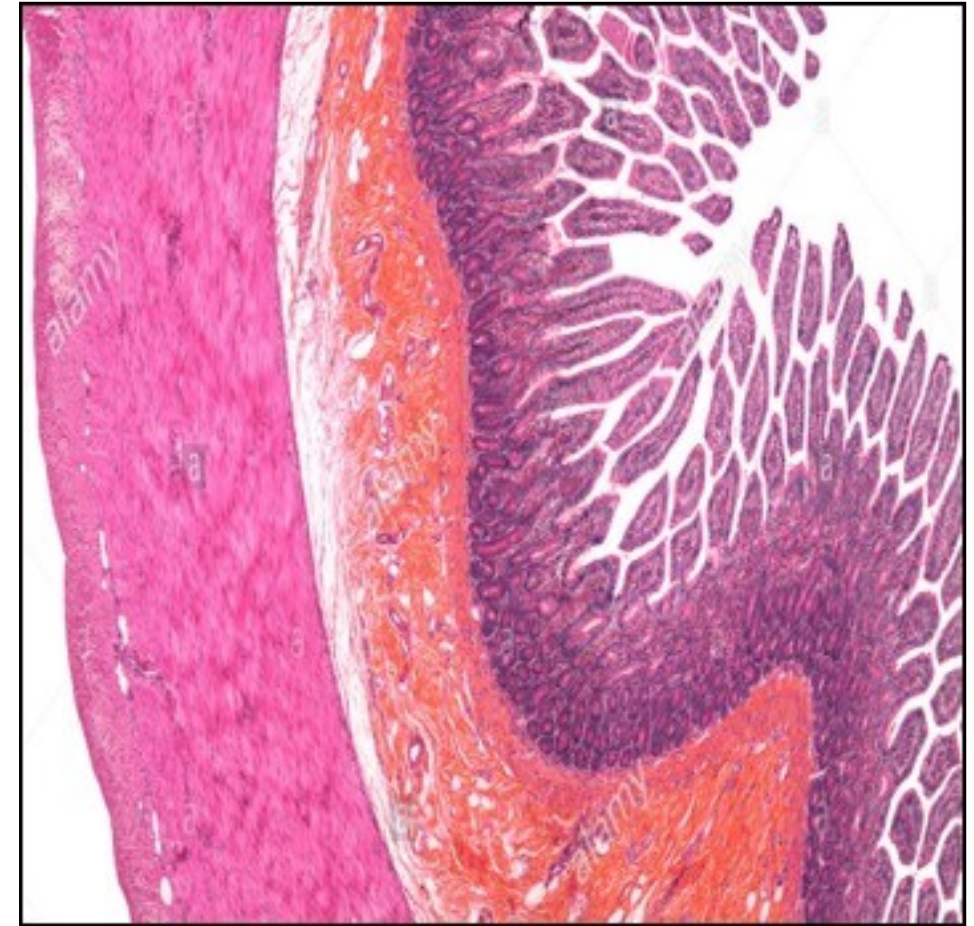
## *General structure of small intestine*



**2. Submucosa:** dense C.T.  
containing blood vessels, lymphatics  
and **Meissner's plexus**  
+  
**Brunner's glands** (in duodenum),  
**Peyer's patches** (in ileum).

**3. Muscularis externa:** IC, OL.  
containing Auerbach's nerve plexus.

**4. Serosa.**



<https://c8.alamy.com/comp/BX54P9/small-intestine-light-micrograph-BX54P9.jpg>

# Lecture Quiz



**Which of the following is present in the mucosa of the small intestine?**

- a. Mucous acini.
- b. Central lacteals.
- c. Myenteric plexus.
- d. Meissner's plexus.
- e. Striated muscle fibers.

# Small intestinal villi

**The core of the villus is formed of:**

**1) Loose C.T.** Extending from the lamina propria, containing lymphocytes, plasma cells and macrophages.

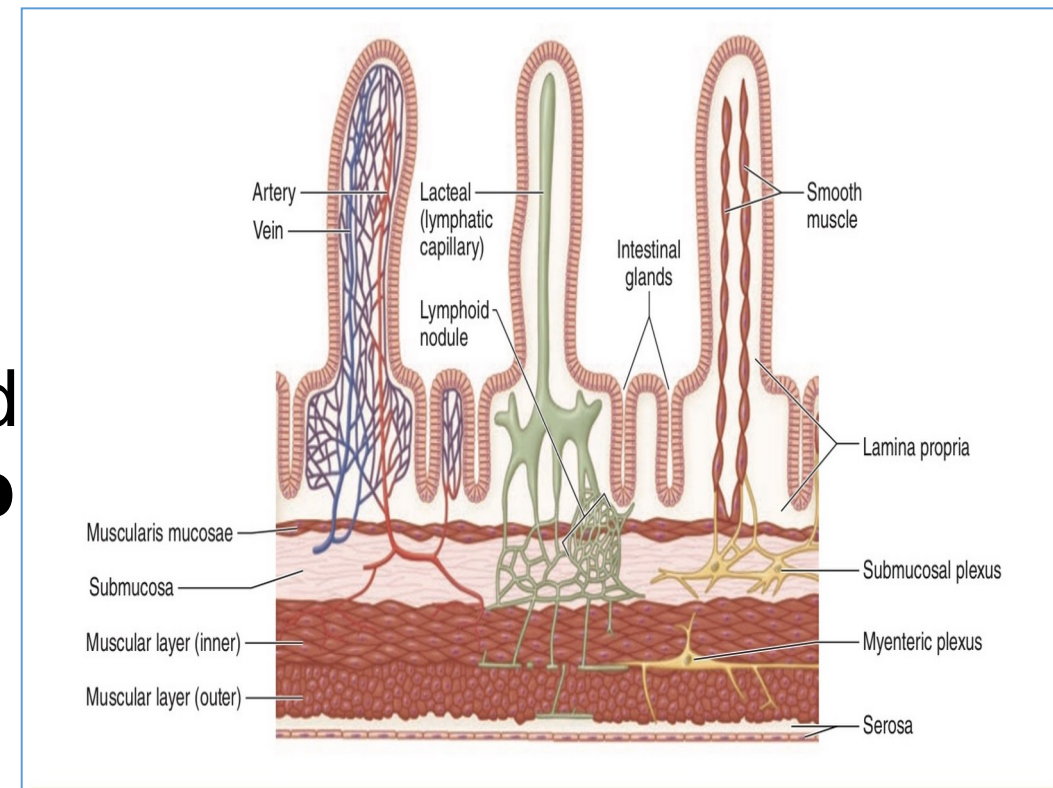
**2) Central lymphatic lacteals:** help in fat absorption.

**3) Smooth muscle fibers** extend from **Muscularis Mucosa** to surround the lacteals. They extend up to the **tip** of the villus.

**4) Fenestrated blood capillaries** Take away the nutrients (absorbed food) to the circulation.



Quora.com







# The cells covering the villi are:

1. Absorptive columnar cells (Enterocytes).
2. Goblet cells.
3. Enteroendocrine cells.





# 1- Columnar absorptive cells (Enterocytes)



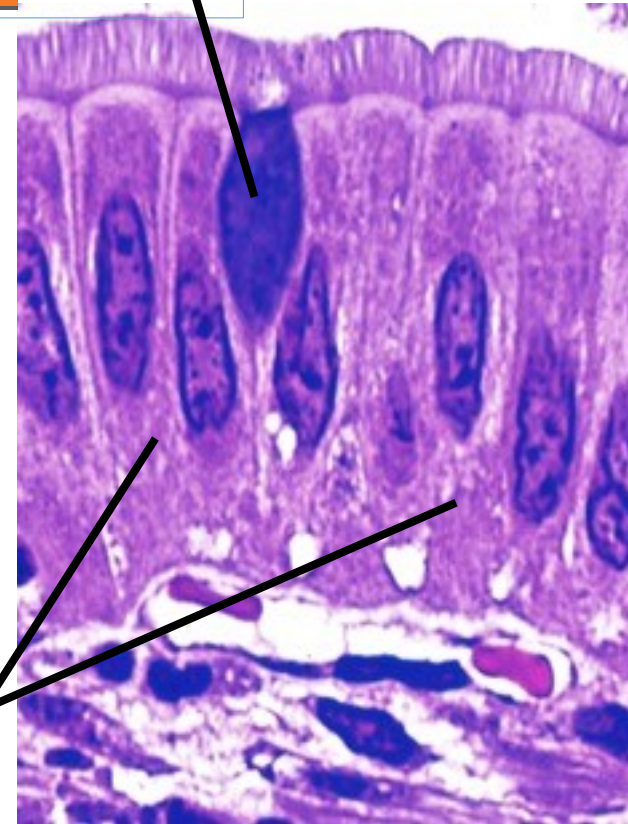
the crypts.

**LM:** - Tall Columnar cells with **apical brush border**

(Striated border, **PAS+ ve**).

- Acidophilic cytoplasm and basal oval nuclei

cells



Enterocytes

## Columnar absorptive cells (enterocytes)

### TEM:

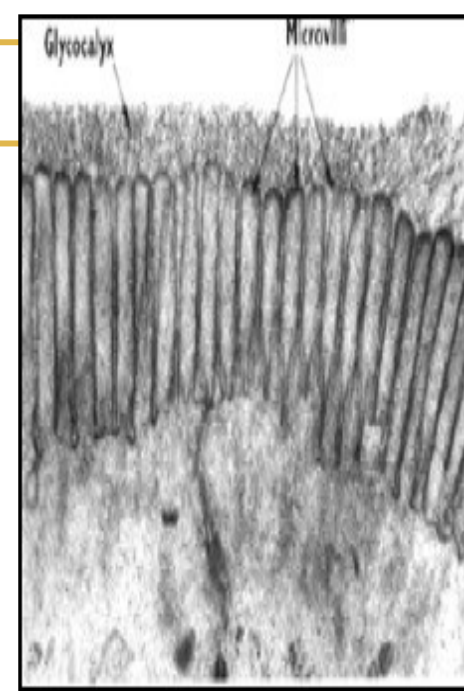
- Numerous Apical microvilli (3000/cell, *increase surface area*). They contain actin filaments and covered by cell membrane and glycocalyx



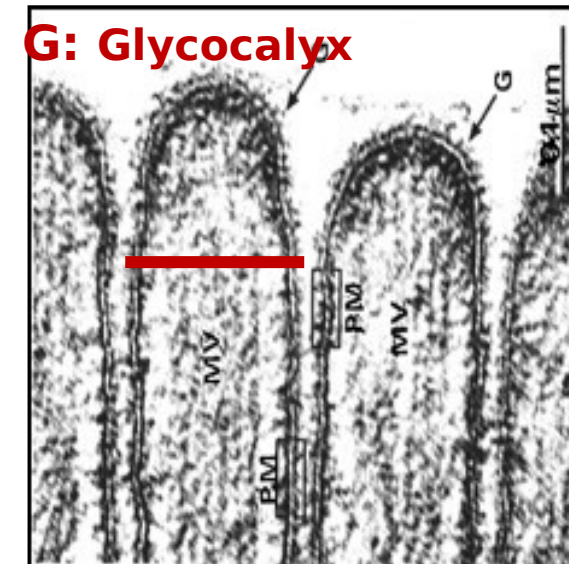
Contain Brush border enzymes (dipeptidases & disaccharidases)

Terminal digestion of proteins into a.a. & CHO into monosaccharides, that are easily absorbed

- The actin of the microvilli insert into **“the terminal web”** (*a network of horizontally oriented actin filament in the apical cytoplasm*).



slideplayer.com



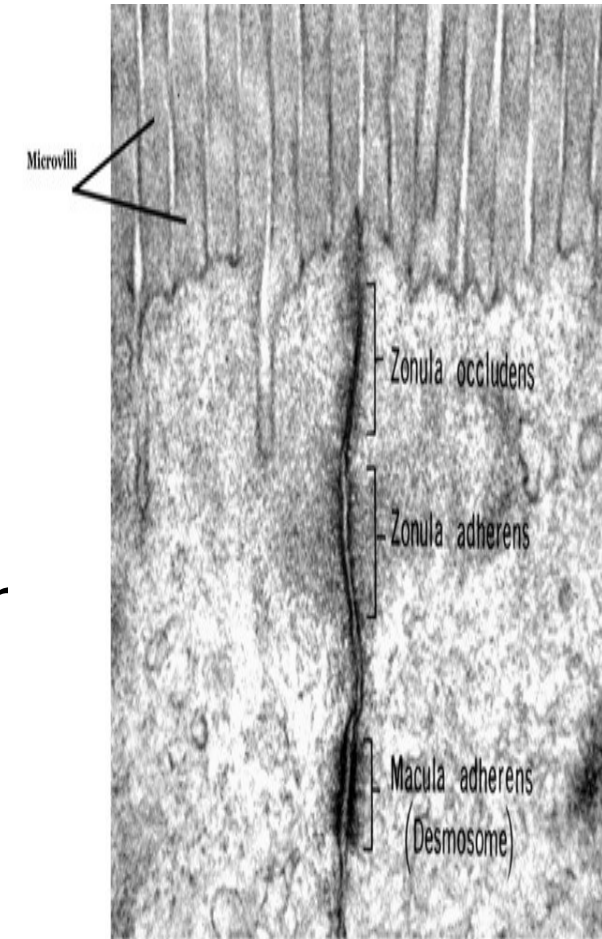
**Microvilli**

## TEM of enterocytes:



- **Junctional complex** between adjacent cells, consisting of zonula occludens (ZO; tight junction), zonula adherens (ZA) and desmosomes.

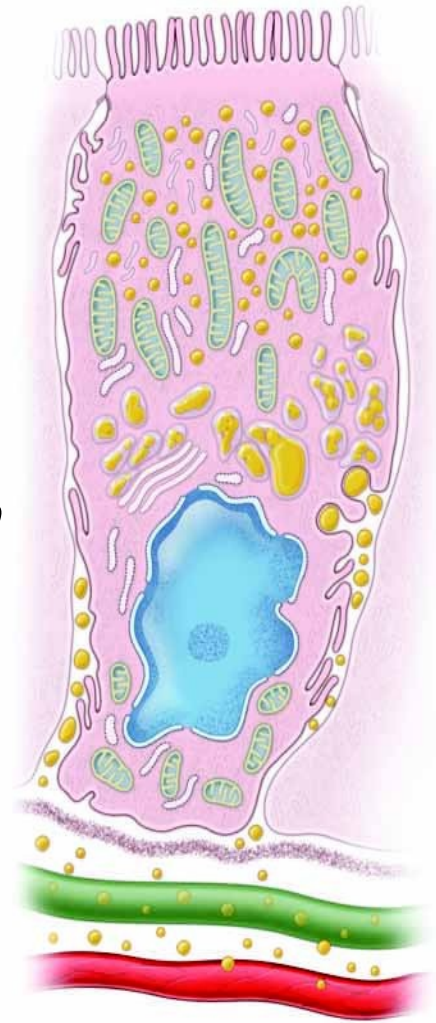
*The tight junctions (ZO) regulate the paracellular movement (i.e. regulate passage of material through the intercellular space to or from the lumen of the gut).*



## TEM of enterocytes:



- **Lateral plications (interdigitation)** are present below the junctional complex *to increase the surface area for fat absorption.*
- rER, Golgi & many mitochondria (*for synthesis of brush border enzymes*).
- **sER** (*for re-synthesis of triglycerides*).



Ross & Pawlina, 7<sup>th</sup> ed



# Organelles involved in fat absorption



**sER**

(re-synthesis of triglycerides)



**Golgi apparatus**

TG combines with apoproteins (formed  
In **rER**) to form **chylomicrons**



**basolateral cell membrane**



**To lamina propria**



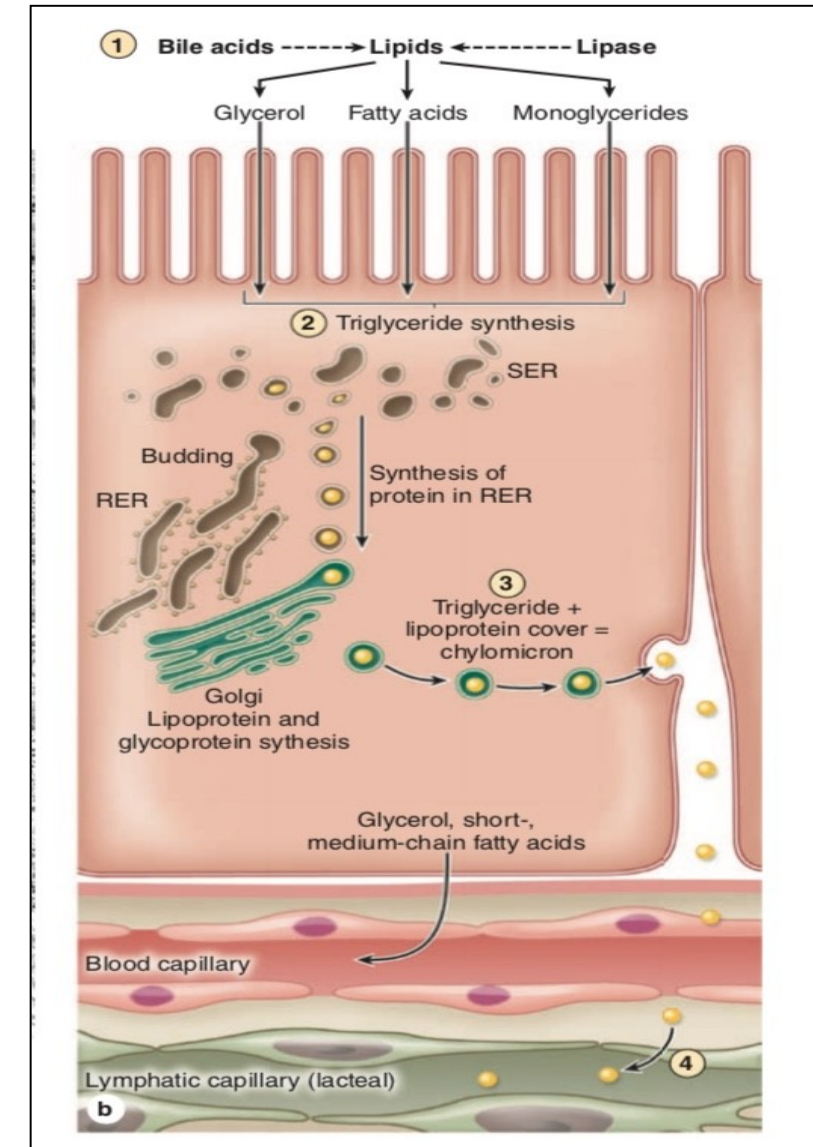
Enter **lacteals**



thoracic duct



blood stream



# Lecture Quiz



**Which of the following is **NOT** a characteristic feature of enterocytes?**

- a. Abundant mitochondria.
- b. Junctional complexes.
- c. Numerous microvilli.
- d. Basal infoldings.
- e. Covered by glycocalyx.

# Clinical application Lactose intolerance



**Absence of lactase enzyme** from the microvilli membrane (*i.e. from enterocytes brush border*)

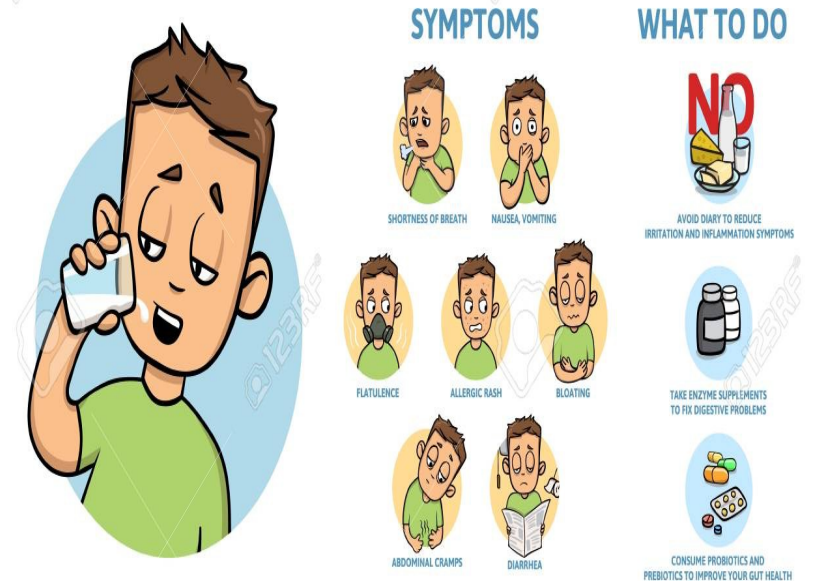
Inability to split lactose (milk sugar) into galactose & glucose

Bloating and diarrhea on consuming milk

May be alleviated upon elimination of lactose from the diet or consuming lactose-free milk or lactase tablets

Occurs in some infants and in adults

## LACTOSE INTOLERANCE





- Cause:  
Immune reaction against gluten, which is found in wheat which affects **enterocytes brush border (loss of microvilli)** and destruction of villi.
- It is associated with malabsorption, diarrhea and abdominal pain.

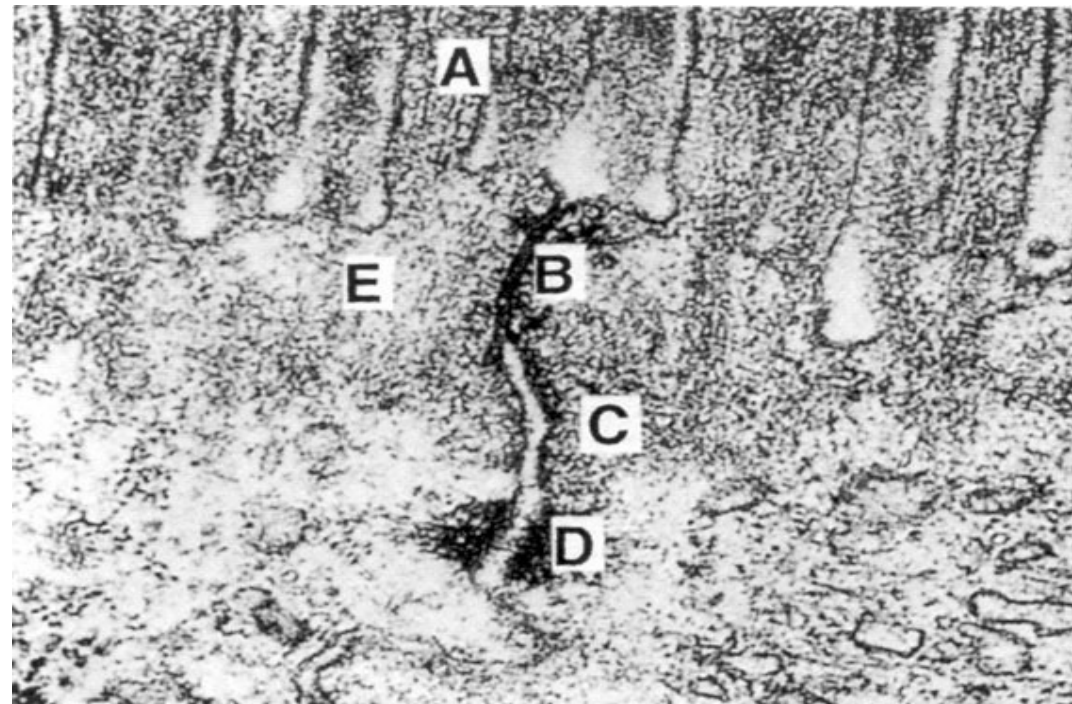




## ***Lecture quiz***



**Regarding the accompanying TEM photo, which area is most likely damaged in Celiac disease?**





# The cells covering the villi are:

1. Absorptive columnar cells (Enterocytes).
2. Goblet cells.
3. Enteroendocrine cells.



Ross & Pawlina, 7<sup>th</sup> ed



## 2- Goblet cells

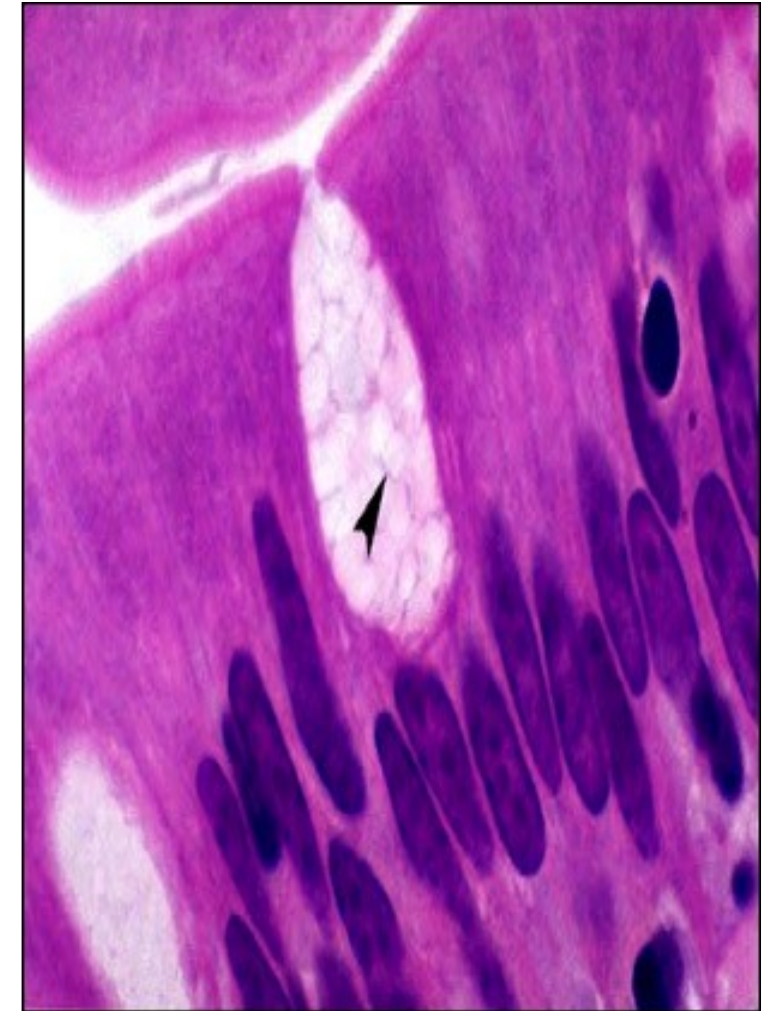
enterocytes over the villi & in the upper parts of the crypts.

### L.M: [Unicellular gland]

- Distended apical pale basophilic, vacuolated cytoplasm (due to dissolved mucinogen granules, PAS +ve).
- Oval vesicular nucleus in the narrow base



**Both brush border & Goblet cells give +ve PAS reaction**



studyblue.com



## ***Goblet cells***

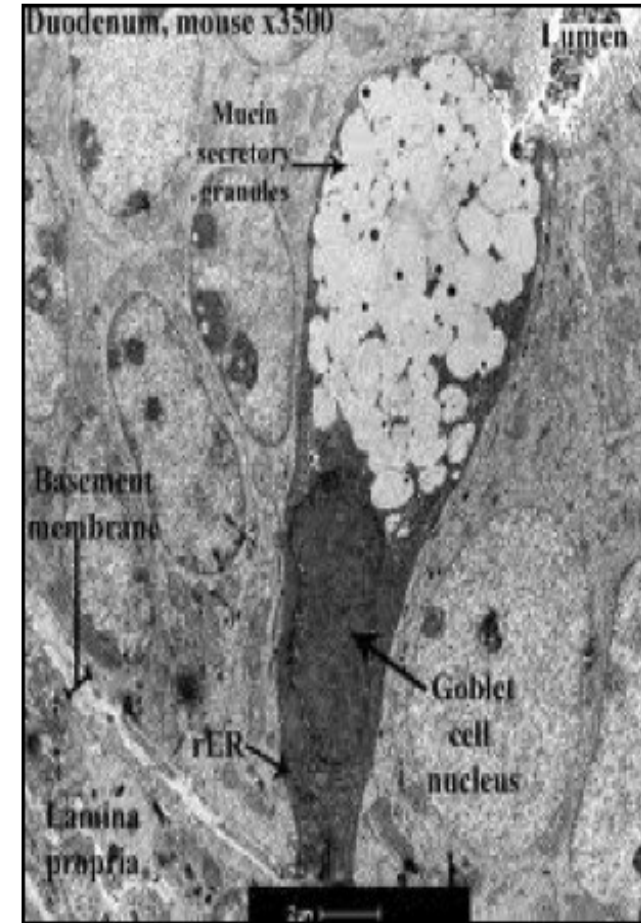


**E.M.**: supranuclear Golgi, rER & mitochondria.

**Function**: Secrete glycoprotein **mucins**, that are then hydrated to form mucus, for protection and lubrication

### **N.B.**

The duodenum has the smallest number of goblet cells. The goblet cells number increases toward the ileum.

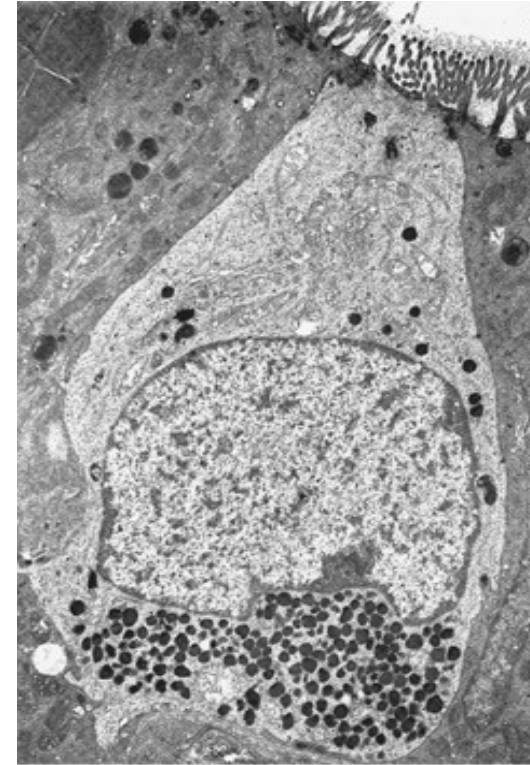




### 3- Enteroendocrine cells



- **Site:** Scattered in villi & crypts.
- **By LM:** Not well distinguished by H&E  
Seen by immunohistochemistry, or silver (so called argentaffin cells), or by chromium (so called enterochromaffin cells).
- **BY TEM: 2 types:** **Open type:** reach the lumen and have apical microvilli (chemoreceptors).
  - Both have basal secretory granules.
- **Closed type:** do not reach the lumen.
- Secrete different hormones, affecting the gut motility, secretion of HCL, proliferation of stem cells, ....



Source: Anthony L. Mescher: Junqueira's Basic Histology: Text and Atlas, 15th Edition. Copyright © McGraw-Hill Education. All rights reserved.

## *Lecture quiz*



A 52-year-old man is diagnosed with a carcinoid. The cells responsible for producing this disorder differ from goblet cells in which of the following?

- a) The direction of release of secretion
- b) The use of exocytosis for release of secretory product
- c) Their presence in the small and large intestines
- d) The origin from a crypt stem cell
- e) Their location in a simple columnar epithelium

## Key points of this lecture



1. Factors increasing the surface area of small intestine.
2. Structural modification of small intestinal mucosa.
3. Structure of enterocytes and goblet cells, enteroendocrine cells in relation to their functions.
4. Brush border structure, enzymes, function and disorders (lactose intolerance, Celiac disease).
5. Organelles involved in fat absorption: sER, Golgi and rER.

# Summary



The **duodenum of small intestine** large mucous glands in the submucosa called **Brunner's glands**.

In all regions of small intestine the mucosa has millions of projecting **villi**, with simple columnar epithelium over cores of lamina propria, and intervening simple tubular **intestinal glands** (or crypts).

Stem cells in these glands produce the columnar epithelial cells of villi, mainly **goblet cells** and **enterocytes** for nutrient absorption, as well as defensin-producing **Paneth cells** deep in the glands

# Summary



**Smooth muscle** of the **lamina propria** and **muscularis mucosae**, under the control of the autonomic **submucosal (Meissner) plexus**, moves the villi and helps propel lymph through the lacteals.

**Smooth muscle** in the **inner circular layer** and the **outer longitudinal layer** of the muscularis, under the control of the autonomic **myenteric (Auerbach) plexus**, produces strong **peristalsis**.



# Suggested textbooks



1- Junqueira`s Basic Histology; Text and Atlas. 14<sup>th</sup> edition 2016, pp: 314-316.

2- Histology atlas and test: Michael H. Ross and Wojciech Pawlina, 7<sup>th</sup> edition, 2015, pp: 572-581



**Thank  
You**

*Mahalo*

**Kiitos**

*Tack*

**Grazie**

**Toda**

*Obrigado*

**Takk**

**Thanks**

**Gracias**

**Merci**